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EUROPEAN PATENT APPLICATION ลิเมอิเครด เกลวทักสมเดา notabli การ published in laccordance with Arts 158(3) EP® สามารถ ประเทศ มายาก เกลราป เ a shees who side whiching justislance. Mere pathoughly inteleies to a martenethoral messe, tool large homerer and (43) Date of publication as no receit 3.0 galbourse bas relember (51) Int CLT: **B23K 9/02**, B23K 9/23 13:02.2002 Bulletin 2002/07 and so received a galverner of and source and source of any source o (86) International application number: (21) Application number: 00950035.6 PCT/JP00/05296

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(84) Designated Contracting States: ibee* OMURA, Tomohiko nego ne atro an -AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU o sect Kyoto-shi, Kyoto,606-8101 (JP) a securi se securi the time state and or be under some and grien ngn **- KONDO, Kunio** va bepabendishe reins (11) a prisuper states in barret at each place place sanda-shi, Hyogo 669-1324 (JP) pninic all LI LV MK RO SI to see in vd agains agid a me of the Cody of Kazuhiros septe of the transfer sente U Nishinomiya-shi, Hyogo 662-0881 (JP) s anothed (30) Priority: ,06.08.1999 JP 22467199 vd anada egiq a ni oj**raHAMADA, Masahiko**cora sie segia laboz — (**880**0) anda Amagasaki-shi, Hyogo 660-0892 (UP) warni ana (71), Applicant: SUMITOMO METAL INDUSTRIES, LTD. [0006] Processes other than those mentioned above a lone Sound of thick (JP) the sound of the so (74) Representative: Uchida, Kenji et al 107 segig liew w mae Cabinet Fedit-Loriot 38 avenue Hocheum of eqyt ding the side agae in side country order to join portion (72) Inventors: [0007] In producing these large-diameter thick-wall pines the submarged are welding mornials. ACHRIVIA large a pril Amagasaki-shi, Hyogo 661-0022 (JP) arit natamed to as "SAW method") is widely deed in producing large-

(54)sct MARTENSITE-STAINLESS STEEL/WELDED STEEL/PIRE with a good level feet to seed to

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[0011] In high-listifue, distincts at booth values 701 or highs, which fallow exclosions of wells in the North Sea, the platform constitution itself is difficult from the waveneim of it is necessary to transport critic oils that usin pipelinas softwar if the made what ballo was determined [Stool d.hr compsive ag and suitable for convolunciation rigids at ion-resistant Some stationss coals which are health count above, and samiliant pities of electric resistance welked hipes relatives welded after the control with a relativest gewoldt davitelen inn etwast flems Milarge-distantor mick-wall widded alo it medelof need to so ODGSEG for air disclosed In JP Kolip Proceeding and JP Kings rent surfar ngg ng pang gapanan dipana ani fonta saulmis **W**

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TECHNICAL FIELD

PURCHER PATENT APPLICATION [0001] This invention relates to a martensitic stainless steel welded pipe excellent in corrosion resistance, in particular in stress corrosion cracking resistance. More particularly, it relates to a martensitic stainless steel large-diameter and thick-wall welded pipe exceeding 20 inches in outside diameter and exceeding 0.5 inch in wall thickness, which is used in a pipeline, in particular a trunk line, for conveying a fluid such as oil or natural gas readily comoding metals.

BACKGROUND ART THA TOTAL INCOMENTAL (88) 10

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[0002] Large-diameter, thick-wall stainless steel pipes exceeding 20 inches in outside diameter and 0.5 inch in wall thickness are widely used in pipelines, in particular trunk lines, for conveying oils or natural gases which readily cause corrosion of metals.

[0003] Such large-diameter, thick-wall pipes are generally produced by a process which comprises forming a thick plate or hot strip into an open pipe or spiral form by bending and then welding the joining portions together. The steel pipes produced by such a process are called UO pipes or spiral pipes.

[0004] UO pipes are produced by a forming process comprising the steps referred to by the alphabetic letters (U and O) indicative of the name given thereto. In this process, a thick plate is formed into an open pipe form bent by using a U press, then the side edges are joined to each other to form a pipe shape by means of an O press and the joining portions are welded together. YH intersylmoninally

[0005] Spiral pipes are produced by forming a hot strip into a pipe shape by spirally bending the hot strip in succession and then welding the joining portions together, side edge to side edge of the strip.

[0006] Processes other than those mentioned above are also available for the production of large-diameter, thickwall pipes. For example, there is a process which comprises forming a thick plate into a pipe-like shape using a 3-roll type forming machine called roll bender and their seam-welding the side edge to side edge in order to join portions of the thick plate together.

[0007] In producing these large-diameter, thick-wall pipes, the submerged arc welding method (hereinafter referred to as "SAW method") is widely used. In producing large-diameter, thick-wall pipes by welding, one-layer welding is generally-carried-out-from-each of inside and outside-of-the-pipe. Further, when the wall-of-the-material-is-thick, multi pass (at least three) layer welding, in which two or more bead layers are formed from one or both sides, may be conducted in some instances.

[0008] - Heretofore, in producing large-diameter, thick-wall welded pipes to be used in conveying fluids; such as oils and natural gases, readily causing corrosion of metals, steel plates made of carbon steel or low-alloy steel containing at most about 1%, by mass of Cr have been used as the base metals together with welding materials. The reason why large-diameter, thick-wall welded pipes made of carbon steel, which is inferior in corrosion resistance, have been used is that carbon steel is economically more advantageous. However, carbon steel is poor in corrosion resistance. Therefore, for pipelines constituted of welded pipes made of carbon steel it has been a common practice to subject the crude oil or natural gas obtained from an oil well to dehydration to the reduce the corrosiveness of the fluids bos [0009] However, the cost of construction of the dehydration equipment and the platform for the installation thereof is high. Therefore, the use of a more corrosion-resistant material has been begun for the production of pipes for pipelines

while omitting the dehydration equipment. The material having higher corrosion resistance includes stainless steel. [0010] In this case, neither dehydration equipment nor platform therefor is required at exploration locations and this fact is very advantageous to the exploration of small-scale oil or gas wells, for example horizontal wells, which cannot have been drilled. Specifically, it is an advantage that crude oils can be conveyed through such pipelines to an existing platform and collectively treated there for dehydration.

[0011] In high-latitude districts at north latitude 70° or higher where future exploration is expected, for example oil wells in the North Sea, the platform construction itself is difficult from the viewpoint of waves on the sea. In that case, it is necessary to transport crude oils through pipelines without dehydration treatment.

[0012] With such background, large-diameter, thick-wall welded pipes enabling the omission of dehydration treatment are more and more desired for conveying fluids readily corrosive against metals.

[0013] Some stainless steels which are highly corrosion-resistant and suitable for conveying such fluids as mentioned above, and seamless pipes or electric resistance welded pipes or laser welded pipes made thereof with a relatively small diameter and a relatively thin wall, have been proposed. As for large-diameter, thick-wall welded pipes made of stainless steel, welded pipes and base metals therefor are disclosed in JP Kokai H10-60599 and JP Kokai H12-8144,

[0014] For the above application, martensitic stainless steel containing 9-13% by mass of Cr are used from the economical viewpoint. This is because martensitic stainless steel has, in addition to the economical feature, sufficient

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corrosion resistance under such circumstances as mentioned above, and is excellent in hot workability and, therefore, can readily be made into thick plates or hot-rolled plates, which are materials for the production of welded pipes. [0015] It has been considered that these martensitic stainless steels used for base metals and the weld metals of seam weld portions are excellent in stress corrosion cracking resistance (hereinafter referred to as "SCC resistance"), carbon dioxide gas corrosion resistance (hereinafter referred to as "CO2 resistance") and sulfide stress corrosion resistance (hereinafter referred to as "SSC resistance" or "sour gas resistance").

[0016] However, it has been revealed that when welded pipes made of martensitic stainless steel are used in a pipeline for conveying a corrosive fluid without dehydration, stress corrosion cracking (hereinafter referred to as "SCC") tends to occur at the weld portion of the pipe inside surface. In particular, with large-diameter, thick-wall welded pipes produced by the SAW method without cutting off the weld bead on the piperinside and outside surfaces, the tendency toward occurrence of SCC is significant. Furthermore, it has become apparent that even if the pipes have SCC resistance, the base metal and weld metal may be poor in sour gas resistance and the weld metal may be high in weld hot cracking susceptibility in some instances.

DISCLOSURE OF THE INVENTION 9 HOUSE Balance :

[0017] to The object of the present invention is to provide a large-diameter, thick-wall martensitic stainless steel welded pipe excellent in corrosion resistance, in particular stress corrosion cracking resistance (SCC resistance); at the base metal portion and the seam weld portion of pipe inside surface and, further excellent in sulfide stress corrosion resist-[0022] The welcod once resistance (CO) resistance (CO) resistance (CO) resistance (CO) and carbon disciplination (CO). [0018] :a The stainless steel welded:pipe of the invention is composed of a base metal which is a stainless steel containing not more than 0.05% by mass of Crand having metallurgical microstructures comprising asfull martensite phase or a martensite phase as the main constituent with a ferrite phase contained therein/and/a seam weld metal which is a stainless steel containing not more than 0.1% by mass of C and 7-20% by mass of Crand having metallurgical microstructures comprising a martensite phase as the main constituent with an austenite phase contained therein. Further, the seam weld bead on the inside surface of the welded pipe of the invention satisfies the base metal is as not rolled it is exact not only in SOC less that now it is early each at it exact it following the heat treatment of the weld portion after welding is omitted that the stances are satisfaction.

> L ≦ 0.2 xW Jegg-P (1)

> > 3.7%

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where L: the length of the portions of the seam weld bead showing a value of h which exceeds 1.25 as calculated by the expression (2) shown below: 1.0 P. 6/8 F + 10

> (2) $h = \{1 + (2 \times H/W)\} \times (YS_{B100}/YS_{w100})$

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For the Prive basic welded pipe, rits also desire to that the Criffly Molanu Ticontents of the base metal as encer before are which with the Carly M. Acade (mm), The selection of the bead from the policies which the carly the carly the bead from the policies which the carly the carly the bead from the policies which the carly the car composition of the weld metal select the relations (5) and (5) ower tellow to this (mm) based entito intbiw entitle men The YSB100: the yield strength of the base metal at 100°C (MPa), no entire or bettime a builder ratio nothing blew edit to YSw100: the yield strength of the weld metal at 100°C (MPa), resuser that tradicate strength of the metal at 100°C (MPa).

[0019] As for the metallugical microstructures of the base metal and weld metal, those of the base metal are desirably constituted of 55-90% martensite phase and 10-45% ferrite phase and those of the weld metal are desirably constituted of 70-95% martensite phase and 5-30% austenite phase, on the volume % basis. [0020] The contents of chemical components other than C and Cr of the base metal and of the weld metal of the seam weld portion of the welded pipe of the invention are desirably within the respective ranges shown below:

> For the base metal, on the mass % basis: M not mole man u co Si 0.01-1%, sol. Al М .. 0-0.5%,---0.05-2%, Mn Zr 0-0.5%, Ni 0-9%, 0-0.05%; Moin : 0:5% -Ca? 0-6%. Mg 0-0.05%

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meter, thick-wall visibled pipes			•		Sed how entry reade of sheet
outside surfaces, the teridencial file cloer have SOC resist	oNI at	0-10%,	Zr ^ s` Ca		produced by the SAW method Toward bodure ide of \$100 8 s
metal may be high in weld be-	W	0-5%, 0-3%	Mg *	0-0.03%	disk , a latern same, one some.
	Cu	0-3%,	Ti	not more than 0.1%	mos ni willaltasoste ceusconi
•			Balance	Fe and impurities	Gravi Brilleo aki 80 0800
			<u> </u>		•

[0021] respondential and weld metal, the contents of P,S and O (oxygen) among the impurities are desirably as follows: Penot more than 0.025%; Senot more than 0.01%; while the content of N is desirably not more than 0.02% for the base metal and not more than 0.05% for the weld metal, and the ancibus is less a basic welded pipe of the invention; and the welded pipe of the invention which satisfied the above conditions is excellent in SCC resistance; in particular and he welded pipe of the invention may be the one last hot golled. Further, this pipe shows sufficient SCC resistance and CO2 resistance even when the heat treatment of the heat affected zone of the base metal and of the weld metal portion is omitted after weldings as any of 202.7 and 0 is assented of the basic welded pipe of the invention desirably fall within the respective ranges given below and further satisfy the relations (3) and (4) given below. In this case; even when the base metal is as hot rolled, it is excellent not only in SCC resistance but also in sour gas resistance and seven when the heat treatment of the weld portion after welding is omitted, these resistances are satisfactory.

30	(1-	Cr Ni	11-20%, 3-7%,	Ti	not more than 0.05%,	
	n exceeds 1 25 as calculated by				Lang at larger in Apply of the larger	where it the length of the horson
					•	word (Whee C) businesses
35			Cr + 1.5M	o - Ni -	· 0.4Cu - 14 ≧ 0	(3)
33	(2)		JO114 SV		Marie & Color From Car	
	•		Cr + 1.5Mo	- 2Ni -	0.8Cu - 12.5 ≦ 0	(4)
						WHICHE

[0024] For the above basic welded pipe, it is also desirable that the Cr, Ni, Mo and Ti contents of the base metal as shown below are combined with the Cr, Ni, Mo and Ti contents of the weld metal as shown below and that the chemical composition of the weld metal satisfy the relations (5) and (6) given below. In this case, even when the heat treatment of the weld portion after welding is omitted, the base metal and weld metal are excellent in toughness and strength and the weld metal portion is excellent with respect to sour gas resistance and weld not cracking susceptibility.

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	Cr, 15:20%, here we make the second of the s	jo
waved awada saga	Weld metal, and the critical metal, and the movement of the metal, and the critical blow me	se
	Cr 11-18%, 3.86 Mo ₁₀ 1.5-4%, and arth 5 Ni 5-10%, W 0-4%, 10.9 R Ni not more than 0.03%, Co 3.0.3 Co 3.0.3	
	The second of th	

 $-1 \le Cr + Mo - 1.7Ni \le 13 - 220 \times O \text{ (oxygen)}$ (5)

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Dadis - For the welded mount exception to tipe (คุณ คุณ คุณ เดิมตา of the convexes of the wine on the aceing the sound and the best blow of 25 ≤ Cr.+ Mo + 1.8NI ≤ 30 episnop your thinks are applied episnop. and the visid strength of the base metal and or thinking the semanature 100°C. As a result the or how con-[0025] addition to the welded pipe mentioned above, the basic welded pipe according to the invention. When the base metal and seam weld metal have the chemical compositions respectively given below on the mass % basis, shows? the highest SCC resistance and configuration of the control of the SCC resistance and the second of is significant. Therefore, the welded upon of the invention act as a good SCC resistance even in tigids containing high concentrations of chloridus and CO_n at high temperatures . Base metal: Office 100°C [0333] The reason why ad vaid soshus sbieni not more than 0.1% 1.0 mant arom ton not more than 0.5%. Si 10 Mn₂, not more than 1%, [U034] In producing the tent ic stainless%60. a zi batai vilarenco (an ∍Cret | 59,17%,moo une 🤝 V_{i} , idublex enunices ethol continuo i in leg%8,0-01 phase and an autrenite phase or a super duplex Itemiers steet@t0.050dp.nor is 60 mm to whats @650 driving eld materials mentioned above the dublex staining a significant impurities, and the case to me base, \$440' whith e subser auctor stainfess SHORE SERVED CONSTR วะอพาสต์สดงกรดสา 🧸 ได้คร Weld metal: istikated araseg knoke componed series The monat anotimore; than 0.1%; the permosal same do a sanivad in Personal that Sinor not more than 0.05%, Cur parko r0-3%p blaw in dold at bels szalnists citiznansm informative perfettion are :Site not more than 0.5%, an addtenite phase in cases where a removement shake well. Viscas V no tends to occur cardin not more than 1%, ⊁:Mn⊃ 9-26% at session and a rotation of the 10-0764% in teorising leading the rest and another of the 20 ite phase and an austenrenar ite phase. В 0-0.01% [0035] The wald metal : aving dual of the property is a strength. It particular is wald strength. It particular is wald strength. It is nite N.S. 00 show more inarkable decreas Balance having substantially single-phase martensite micros, write out the green the yield strength of the weld metal is I [0026] The above-mentioned welded pipe of the invention is most suited for use as a pipe for a pipeline for conveying: crude oil or natural gas without dehydration is referred one osu unrub noisnet of euro seems good second number of each total of less than 20 inches (508 mm) and the term "thick wall" means not less than about 0.5 inch (12.7 mm). The terms "martensite phase as the main constituent" means that the martensite phase proportion exceeds 50% by volume. at the weld bead toe on the pibe inside surface is proven SOS eoned woled begins as a serior of the BRIEF DESCRIPTION OF THE DRAWINGS 30 of more specifically. The representation by 32 [0036] In the following the welded gibe of the invention is amine. [0028] the content of each chemical component means % or maps Fig. 1 is a schematic drawing illustrating the sectional structure of the seam of an ordinary large diameter, thicks 35 wall welded pipe. Fig. 2A and Fig. 2B are drawings illustrating the method of providing a bending stress for the SCC resistance and sour gas resistance tests as used in the examples. Fig. 2A is a sectional view of a jig for providing a bending stress. and Fig. 2B is a drawing illustrating a state of a 4-point bending stress being imposed. Fig. 3 is a schematic representation of the sectional structure of the weld made from the single pass weld material 100+181 JOHES JA WARH X 2) + H = 4 (2) used in Examples 1 and 2. Fig. 4 is a drawing showing the site of test specimen sampling for the tests made in the examples, namely the site of collection of 4-point bending test specimens from the single pass weld material for SCC resistance and source and sour gas resistance testing. of collection of 4-point bending test specimens from the welded pipe for SCC resistance and sour gas resistance . pritest is taken as a standard index value. And milegalish in the west read direction of these convexes of the BEST MODES FOR CARRYING OUT THE INVENTION (1) is determined a determined to show a december of the shown and show a determined to show 56 50 [0029] As mentioned above, crude oils and natural gases, when the treatment for dehydration thereof is omitted, may cause corrosion of metals. When large-diameter, thick-wall martensitic stainless steel welded pipes produced by the SAW method are applied to pipelines for conveying such fluids, stress corrosion cracking (SCC) generally tends to occur on the seam weld on the pipe inside surface.

100301. The present inventors revealed that the above SCC occurs mainly at the weld bead toe. They elucidated the property of the present inventors revealed that the above SCC occurs mainly at the weld bead toe. They elucidated the present inventors revealed that the above SCC occurs mainly at the weld bead toe. They elucidated the present inventors revealed that the above SCC occurs mainly at the weld bead toe. They elucidated the present inventors revealed that the above SCC occurs mainly at the weld bead toe. cause thereof and have now completed the present invention.

[0031] Fig. 1 is a schematic drawing illustrating the sectional structure of the seam weld of an ordinary large-diameter.

thick-wall welded pipe.

[0032] For the welded pipe 1 according to the invention, the size and number of the convexes of the weld on the pipe inside surface are restricted by considering the width and height of the weld bead 3 on the pipe inside surface and the yield strength of the base metal and of the weld metal at the temperature 100°C. As a result, the stress concentration at the weld bead too 4 caused by the shape of the weld bead is suppressed and it becomes possible to prevent the occurrence of cracking caused by the difference in strength between the base metal and weld metal at high temperatures up to 100°C. In particular, the synergy effect in preventing the SCC resulting from those two effects is significant. Therefore, the welded pipe of the invention exhibits good SCC resistance even in fluids containing high concentrations of chlorides and CO₂ at high temperatures up to about 100°C.

[0033] The reason why-SEC tends to occur at the toe 4 of the weld-bead-3-on the pipe inside surface may be mentioned more specifically as follows.

[0034] In producing martensitic stainless steel welded pipes, the weld material (welding wire) generally used is a duplex stainless steel containing not less than 22% by mass of Cr and comprising a ferrite phase and an austenite phase or a super duplex stainless steel containing not less than 25% by mass of Cr. Of the weld materials mentioned above, the duplex stainless steel is superior in corrosion resistance to the base metal while the super duplex stainless steel is superior in corrosion resistance and strength to the base metal. When, on the other hand, a martensitic weld material having the same component series as the base metal is used, the weld material is selected among those having a chemical composition allowing the formation of an austenite phase in the weld metal. The reason is that since martensitic stainless steel is high in weld cold cracking susceptibility, the cold cracking should be inhibited by forming an austenite phase. In cases where a ferrite phase is present in the weld metal, weld not cracking tends to occur readily and therefore the metallurgical microstructures should comprise two phases, namely a martensite phase and an austenite phase.

[0035] The weld metal having dual phase microstructure containing austenite phase shows more markable decreases in strength, in particular in yield strength, at high temperatures up to about 100°C as compared with base metals having substantially single-phase martensite microstructures. Therefore, the yield strength of the weld metal is lower than that of the base metal in a high temperature service environment. In particular when used in a pipeline, the pipe undergoes hoop stress due to tension during use and, therefore, greater strains are imposed on the weld metal interior in yield strength than on the base metal. The reason why SCC tends to occur at the weld bead too is that the tensile stress and the stress concentration in the weld bead overlap with each other, which result in an excessive increase in the strain on the weld metal side of the weld bead too. Where the welded pipe of the invention is concerned, the strain at the weld bead too on the pipe inside surface is prevented from occurring by the means described below, hence SCC hardly occurs.

[0036] In the following, the welded pipe of the invention is described more specifically. The representation by % of the content of each chemical component means % by mass.

Shape of the weld bead on the pipe inside surface:

the following equation (2): vorus as state of the part of the part

Fig. 3 is a acrematic representation of the sections, structure of the weld made from the single bass weld marerial

(2) used in Examples 1 and 2. (00tw 2Y₀₀₁₈2Y) x {(WH x S) + t} = d Fig. 4 is a drawing snowing the site of test specimen is a military the tests made in the examples inamely the site

Fig. " I see senom de promot divisirsona ma republic

[0038] In formula (2), H (mm) represents the height of the weld bead 3 from the pipe inside surface, W (mm) the width of the bead, YS_{B100} (MPa) the yield strength of the base metal at 100°C and YS_{w100} (MPa) the yield strength of the weld metal at 100°C.

[0039] For the welded pipe of the invention, the value of the index had defined by the above formula (2) which is equal to 1.25 is taken as a standard index value. And, the length L, in the weld bead direction, of those convexes of the welded pipe whose h exceeds 1.25 is determined. L should satisfy the following relation (1):

[((中)29] As mentioned Rapys. Lade oils and hatche**W x's.0 ≧ J** → he treatment for dehydration thereof is omitted may bause corrosion of metals. When large-diameter, they are traitic stair less stoot welded pipes produced by

[0040] 'I The reason why SCC resistance evaluation is made based on the combination of h = 1.25 and relation (1) is that this combination enables the most accurate appreciation of the SCC resistance.

[0041] In the case of spiral welded pipes, the term "in the weld bead direction" as used herein means, the direction of the fusion line of the spiral seam. The above standard is very effective for evaluating, for SCC resistance, welded pipes particularly intended for conveying high-temperature fluids untreated for dehydration, such as crude oils rich in

chlorides and containing carbon dioxide gas in section of the real bandon too billit containing carbon dioxide gas in section of the real bandon too billit containing carbon dioxide gas in section of the real bandon too billit containing carbon dioxide gas in section of the real bandon too billit containing carbon dioxide gas in section of the real bandon too billit containing carbon dioxide gas in section of the real bandon dioxide gas in section [0042] Referring to the above formular(2), the yield strength values at 100°C for the base metal and weld metal are employed because, in those pipelines where the welded pipe of the invention is mainly used, the pipe inside temperature isigenerally at most about 100°C/1 most and of a construct as taken send out to motion the enterior [0.347] the appet that of the content is decreably higher as condent in the base restable that the resement can be Metallugical microstructures of the base metal and weld metal; edge and auch distant easily and neith digneric intranget not nitize than 0.03% for the base malatiand is not more than 1.1% ... the weld mota. [0043] The metallugical microstructures of the base metal should consist mainly of a martensite phase containing a feirite phase Although the base metal may comprise a full martensite phase, a thickiplate or hot rolled plate with a single phase) which is the material for a welded pipe, is excessively high in strength, hence the conditions of use thereof are restricted for example it is less workable and the welded pipe as welded condition can hardly be used without heat treatment after production. Therefore, for obtaining an appropriate level of strength, the metallurgical microstructures of the base metal should be such that the martensite phase proportion exceeds 50% by volume and a ferrite phase is contained therein. The ferrite phase proportion may be 0% The martensite phase volume becentage in the metallurgical microstructures is desirably 55-90%. The ferrite phase accounts for the remainder and the volume per centage thereof is desirably 10-45% the account of the second of the property [0044] The strength of the base metal as hot-rolled or as welded for pipe production is desirably equivalent to the X-80 grade of strength (551 to 689 MPatin yield strength) as defined in the relevant API standard. For attaining such strength; it is necessary that the microstructures contain a soft ferrite phase; namely the bferrite phase; as a second phase. When the martensite phase proportion exceeds 90% by volume; the strength becomes excessively high and local deformation may occur in the weld portions during the construction of a pibeline It is therefore desirable that the martensite phase account for not more than 90% by volume in ambly the ferrite phase account for not less than 10%? so as to suppress the increase in strength? When, on the other hand, the martensite phase proportion is less than 65% by volume, a yield strength corresponding to the X-80 grade may not be secured in some instances. Therefore the and on the weld hot crecking susceptibility of the w%00F-25-8i against paragraphic susceptibility s [0045] moThe volume ratio between the martensite phase and ferrite phase in the metallurgical microstructures can be determined by the point counting method. According to this method microscopic photographs of the metalluraical microstructures at a magnification of 13000 (7.3 cm x 9.5 cm) are taken in 5 fields and further 44 fold enlargements thereof are printed. Then, unit lines are drawn on these photographs at 5-mm pitches and all the grids are examined while giving the point when a grid is within a martensite phase (0 (zero) point when it is within a feir it base and 0.55 point when it is on the boundary between a martensite phase and a ferrite phase Further, the total humber of drids is calculated and the proportion of each phase is determined by dividing the score ໃນປີເຂົ້າຄວາມ ເຄື່ອນ ເຄື່ອງ [0038] For producing the deoxiclizingsand that are produced the representation of the real state of the representation and the representation of the real state of the representation of the represent [0046] The metallurgical microstructures of the weld metal mainly comprise a martensile phase and contains an austenite phase?The microstructures should contain an austenite phase so that the strength toughness cold works? bility and weld hot cracking resistance of the weld metal portion can be secured স he austenite phase proportion is desirábly-5-30% by volume (with the martensite phase proportion thus being 70-95% by volume (with the martensite phase proportion thus being 70-95% by volume (with the martensite phase proportion thus being 70-95% by volume (with the martensite) the fusion welding method, which tends to increase an O (oxygen) content in the weld metal portion, is used the [0061] The upper limit of the Mn contessandguot principles is effective for securing toughness and contessand principles in the Mn contessandguot principles is effective for securing toughness. [0047] "oThe austenite phase volume percentage (%) in the martensitic microstructures can be determined by the following methods For a pipe or plate, the intensity ratio of the austenite (220) diffraction pattern to the martensite phase {211} diffraction pattern is determined for each of three sections; namely a section in the direction of rolling; a section perpendicular to the direction of rolling and a section parallel to the surface, by the X-ray diffraction method using the Co-Krárray as the primary Xiray. The austenite phase volume percentages are the nicalculated based on the measured. values for the three sections and the mean values of the results is calculated. [0048] veSince, however the martensite phase and austenite phase differ in diffraction pattern intensity hence errors may occurre due to the differences in characteristics from apparatus to apparatus; it is necessary to make in characteristics corrections using a standard sample composed of marsensitic stainless steel and austenitic stainless steel blended in strength and toughness in the welding heat affected zone. When other hand, the other bandmataband a is higher than 9%, the Ms count lowers and the strangth teached wherease. A more desirable upper limit is 7% [9064] In the weld metal. Ni is effective for more asing the statem blaw bnarlatem based entitle (metal-statem) and the weld metal-statem blaw and the common statem. to obtain such effect. Ni is contained. For producing that their thoils content is desirably not less than 2% more [0049]: *C:*When the C content is high, both the base metal and weld metal increase hardness? When the hardness? is high, the SCC resistance and sour gas resistance decrease, so that a low C content is desirable. For the base metal, in particular, the C content should be as low as possible and, when the C content is over 0.05%, the hardening in the welding heat affected zone becomes significant. In that case, the difference in yield strength between the base metal and weld metal portion increases and strains tend to be concentrated on the weld metal side at the boundary between the weld metal portion and welding heat affected zone at the weld bead toe. When such a welded pipe/is-applied for

conveying a high temperature fluid not treated for dehydration but containing chlorides in large amounts under a carbon dioxide gas environment, it is apt to undergo stress corrosion cracking. Further, in an environment containing a trace amount of hydrogen sulfide, its sourigas resistance decreases markedly. Souries a source of source amount of hydrogen sulfide, its sourigas resistance decreases markedly. Source of the Content of the base metal is determined to be not more than 0.05%. As for the weld metal, the upper limit of the C content is desirably higher as compared with the base metal so that the weld metal can be higher in strength than the base metal; thus, the upper limit of the C content is set to 0.1%. Desirably, the C content is not more than 0.03% for the base metal and is not more than 0.05% for the weld metal.

[0051] at Cr. Cr. Cr. is an element improving the corrosion resistance; in particular the CO2 resistance. When the Cr content of the base metal is less than 9% and that of the weld metal is less than 7%, the CO2 resistance is not sufficient for the pipe to be used in conveying a carbon dioxide-containing fluid readily corroding metals of or example natural gas or crude oil with no dehydration treatment. Therefore, the lower limit of the Cr content is set to 9% for the base metal hear treatment after production. Therefore, for obtaining on some increase of strength, in taken blew, after both to the account of the contract of the contra [0052] a The upper limit of the Cr. content is set to 20% for both the base metal and weld metal; When the Cr content of the base metal is over 20%, the martenaite transformation temperature (Ms point) lowers, hence it is difficult to obtain metallurgical microstructures; mainly comprising a martensite phase. In particular, when a plate as hot rolled is used as the base metal for the production of a welded pipe, it becomes difficult to secure the desirable lower limit; namely:55% [0053] miWhen the Gr.content of the weld metal is over 20%; ferrite phases tend to be formed. In that case; the metallurgical microstructures of the weld metal portion will not become dual phase microstructures mainly comprising a bhase. When the martensite phase proportion exceeds and estimateus insignification bhases and estimated attentions and estimated attentions and estimated attentions and estimated attentions are supported at the control of the contr [0054] in Therefore, the Cricontent of the base metal should be 9,20% and that of the weld metal 7,20%. Since the CO2 resistance is more improved as the Cr content is higher, a desirable Cr content range is 114-20% more desirably 15:20%, for the base metal and 11:18%, more desirably 41:15%, for the weld, metal, or ease one aft as a course of as a co [0055] of The Cr content exerts important influences also on the sour gas resistance of the base metal and weld metal and on the weld hot cracking susceptibility of the weld metal. These corrosion resistances are also influenced by the contents of other elements, for example Ni, which are austenite phase forming elements. Therefore, it is recommended that the Cr. content is selected considering the contents of such elements, as mentioned later hereing ye benemeleb [0056] =0. The elements mentioned below are elements which may be contained in the base metal when necessary, m [0057] exSi3-Si is an element effective for deoxidation of the molten steel in the production of the loase metal and in deoxidationsofathe fusion zone in the step, of welding. Since, however, the toughness tends to decrease when the Si content is higher, than 1%; the content of Si, when it is used as the deoxidizer is desirably not more than 4 % ton the base metal as for the weld metal. A more desirable upper limit is 0.5% a does to not proportion of each as well as for the weld metal. A more desirable upper limit is 0.5% a does to not proportion of each as well as for the weld metal. [0058] For producing the deoxidizing effect of Si, it is desirable that the Si content be not less than 0.01 % n A more [0046] The metallurgibal microstructures of the walk metallurgibal microstructures of the walk made \$\cdot \cdot \ [0059], & Accordingly, a desirable content of Si, when it is contained, is 0.01-1%, more desirably 0.05-0.5%, atinataus [0060]: Mn: Mn: is an element effective for improving the deoxidation of the molten steel in the production of the base metal, or the deoxidation of the fusion zone in the step of welding; and the hot workability of the steel. For producing these effects, it is desirable that its content is not less than 0.05% for both the base metal and weld metal. noteur ent [0061] The upper limit of the Mn content is preferably set at 2% for both the base metal and weld metal when the Mn; content; of the base metal is: over 2% regregation of Mn tends to occur, within the slab for the production of the base metal, hence a decrease in toughness may occur due to the segregation of Mn; and also the SCC resistance tends to decrease. A desirable upper/limit of the Mn content of the base/metal is 1%. When the Mn content of the weld metal/exceeds/2%, the toughness and SCC resistance are apt to decrease as golden to notice the of relucibnemed [0062] SelAccordingly, when Mn is added, the Mn content is 0.05-2% desirably 0.05=1%, for both the base metal and weld metal. values for the three sections and the mean values of the results whateo

weld metal.

[0063] a Nij Nij is an element effective for securing the toughness of the welding heat affected zone in high-level heat input welding. Therefore, Ni is contained when it is necessary to attain that effect when its content is contained when it is necessary to attain that effect when its content is contained when it is necessary to attain that effect when its content is cless than 3%; the amount of ferrite in the welding heat affected zone may become excessive; leading to failure to obtain sufficient strength and toughness in the welding heat affected zone. When, on the other hand, the Ni content of the base metal is higher than 9%, the Ms point lowers and the strength tends to decrease. A more desirable upper limit is 7%.

[0064] In the weld metal, Ni is effective for increasing the austenite phase proportion. Therefore, when it is necessary to obtain such effect, Ni is contained. For producing that effect, the Ni content is desirably not less than 2%, more desirably not; less than 5%. When the Ni content of the weld metal is over 10%, the effect of Ni saturates and an increased cost is caused; hence the upper limit of the Ni content of the weld metal is preferably set to 10%. The region of the Ni content of the weld metal is preferably set to 10%. The region of the Ni content is desirably 3-9%, more desirably 3-7%. Open and the region of the base metal to contain Ni, its content is desirably 3-9%, more desirably 3-7%. When the weld metal contains Ni, the content thereof is desirably 2-10%, more desirably 5-10%. Since Co has almost the same effect as that of Ni; Co may be substituted for part of Ni, and contains the later of the base metal and of the later of the base metal and of

the weld metal. Therefore, when the welded pipe is to be used for conveying a hydrogen-sulfide-containing fluid, at least one of those elements is preferably contained. Mo and Cu are particularly effective for improving the sour gas resistance. If the east end to make a source to the content of each of the elements in the base metal and in the weld metal is preferably not less than 0.5%. As for the base metal, however, when the Mo content exceeds 5%, the toughness in the welding heats affected zone decreases and, when the W-content exceeds 6% and the Cu content exceeds 5%, the hot workability lowers. As regards the weld metal, when the Mo content exceeds 5% and when the W-content and Cu content exceeds 6% and 3%, respectively, the weld hot cracking resistance decreases: W [35001] [0068] 514 Accordingly, when these elements are added to the base metal; the content is 1.5-4% and according of the Cu content is 1-3%.

[0069] As for the weld metal, the Mo content is preferably 0.5-5% and each of the Woontent and Curcontent is preferably 0.5-3%. A desirable range of the Mo content is 1.5-4% and a desirable range of the W content and of the [0084] As mentioned hereinabove, the walded pipe of the exercise shows excellent SFC reviews. Servicing training [0070] Sol: "Ale Al is an element effective for deoxidation of the molten steel in base metal production or of the fusion zone in the step of welding. For obtaining the deoxidation effect of Al; it is recommendable; that the soli Al content is not less than 0,001% for the base metal as well as for the weld metal. When on the other hand, the sole Al content is over 0.1%; Falumina clusters readily remain in the base metal or weld metal, hence toughness decreases A 17200] [0071] PFAccordingly, when Allis added, the soll Al content is preferably 0:001-0.1% for both the base metal and weld metal? Addesirable content range is seen of 1000 professional of the base of [0072]/24V and Zra Each of these elements is effective for fixing C and Neim the steel as the carbide in initial each thereby reducing the variations in strength; such as yield strength; of the base material and of the weld metal. When iti's necessary to obtain this effect; it is recommended that at least one of the elements is contained. That effect becomes significant at a content of not less than 0:001% for each element. However, when the content of these elements exceeds 0.5% for the base metal or 0.3% for the weld metal, the base metal and weld metal both tend to decrease toughness of not loss than 10% by volume and a martenaite phase property and more than 90% by sonaiziem notion of the [0073] Accordingly, when these elements are added, a desirable content of each element is 0:001-0.5% pmore de sirably 0.001-0.3%, for the base metal and 0.001-0.3%, more desirably 0.001-0.2% for the weld metal freque assets [0074] (Car and Mg): These elements are effective for improving the hot/workability of the base metal? Eurthermore; they are also effective for preventing nozzle choking at a time of casting a slab for the base metal by continuous casting: Therefore, when it is necessary to obtain these effects, at least one of the elements is preferably added. The effects of these elements become significant at a content of not less than 0.0005% each. However, when the content of each exceeds 0.05%, coarse oxide particles thereof tend to remain in the steel, so that the toughness of the base metal tends to decrease and the particles may serve as initiation sites of pitting to reduce the corrosion resistance.

[0075] Accordingly, when these elements are to be contained in the base metal, their content should preferably be 0.0005-0.05% for each of Ca and Mg. A desirable range is 0.0005-0.03%, more desirably 0.0005-0.01%.

[0076] Ca and Mg can fix S in the weld metal and improve the weld hot cracking resistance. For obtaining the effect of these elements they are preferably contained at a content of not less than 0.0003%. When however, the content of these elements is over 0.03%; coarse oxide particles thereof readily remain in the weld metal and; in such cases, the toughness decreases and the coarse oxide particles serve as initiation sites of pitting to possibly decrease the icorrosion resistance a Therefore when these elements are added a desirable content of each Casand Masis this crecking is chemical composition should be selected such that forthe phase occurs in appropriate a co. 2000(0: [0077] "Til In cases where the metallurgical microstructure of the base metal is constituted of a martensite phase and a ferrite phase, the presence of Ti reduces the toughness of the base metal. In particular when the Ti content/exceeds -0!1%; the decrease in toughness becomes significant. Therefore the Tircontent of the base metal is preferably ก็ดัง more than 0.1%?A desirable Ti content level is not more than 0.05% and a more desirable one is not more than 0.015%: [0078] °COn the other hand} This generally added to the weld material to stabilize the welding arc. Therefore, Thremains ากithe weld metal. The influence of Ti on the toughness of the weld metal is relatively slight but) at over 0.1% (the toughness tends to decrease. The refore the Ticontent in the weld metal is desirably not more than 0.1%, more desirably be within the following respective ranges: On 15-20%, %00.0 more than 0.03%, %00.0 more than 0.05%, still more desirably not more than 0.05%. [0079] P. S. Nand O among impurities: Each of them is an element existing as an impurity and the content thereof 1.5-4% W. 0-4% and Trinot more than 0.03% and the didizion sa wolfas ediblional listem binarios of the didizion and the didizion that the didizion of the didizion that the di [0080] When the P content exceeds 0.025%, the corrosion resistance and toughness of the base metal and weld metal tend to decrease. Therefore, the P content is preferably not more than 0.025%. A level not more than 0.015% is more desirable and a level not more than 0.01% is still more desirable.

[0081] When the S content exceeds 0.01%, the hot workability, corrosion resistance and toughness of the base metal and the hot cracking resistance, corrosion resistance and toughness of the weld metal tend to decrease. Therefore, the S content in the base metal and in the weld metal is preferably not more than 0.01%, more desirably not more than

0.005%, still more desirably not more than 0.002%. The weld mess. The second of the terminal part of the second [0082] 62 When the N content exceeds 0.02% in the base metal or over 0.05% in the weld metal, the toughness and corrosion resistance of the base metal as hot rolled or as welded show a tendency toward decrease and the toughness and corrosion:resistance of the weld metal tend to decrease. In particular, the toughness of the welding heat affected zone of the base metal and the sour gas resistance of the base metal and of the weld metal tend to decrease. Therefore, the N content of the base metal is preferably not more than 0.02% and that of the weld metal not more than 0.05%. For both metals; the N content; of not more than 0.01% is more desirable. 3A are wolly discovered to the content; of not more than 0.01% is more desirable. [0083] When the O (oxygen) content exceeds 0.01%, the toughness and corrosion resistance of the base metal and of the weld metal tend to decrease Therefore, the O content is desirably not more than 0.01%, more desirably, not C 5-5% and one of the content or preferable 0.5-5% A description on the Mologonian is \$1.5 to another the monocontent of the content of the c Preferred; modes of the chemical composition: A second and address of the werit to a A [9600] proferably 0.6.3%. A desirable range of the Me continue (1.5%) and a desirable lange of the Wichstein and of the [0084] As mentioned hereinabove, the welded pipe of the invention shows excellent SCC resistance when used for the conveyance of crude oils or the like without treatment for dehydration. Further, as described under "Disclosure of Invention", the welded pipe of the invention can have further beneficial characteristics when the base metal or weld metal satisfies the following conditions: with respect to the chemical composition thereof. add to 1 2000 0 4571 sast lon [0085] As already, mentioned hereinabove, it is desirable that the metallurgical microstructures of the base metal is constituted of 55-90% martensite, phase and 10-45% ferrite phase. For securing such metallurgical microstructures and at the same time obtaining a base metal:excellent in strength; and toughness and further showing such; corrosion resistance features as sourgas resistance even when the heat treatment after hot rolling in the process of base metal plate production and/or the heat treatment after welding is omitted, it is desirable that the following conditions is satisfied. [0086] edThe:@reNifand-Ti contents of the:base metal should be as follows::Cr. 11;20%;eTi:not@nore.than.0.05%;eNif 3-7%: And, when the base metal contains Mo, the contents of the elements including these should satisfy the relations (3) and (4) shown below: simultaneously. The relation (3) is a condition favorable to obtaining a ferrite phase proportion of not less than 10% by volume and a martensite phase proportion of not more than 90% by volume while the relation (4) is a condition favorable to obtaining a martensite phase proportion of not less than 55% by volume and a ferrite strably 0.003-0 2%, for the base metal and 0.003-0.00 serbly amuloyized 45P nadr anom, for its opening only of [0087]enThe symbols of elements in the relations (3) and (4) denote the contents (% by mass) of the respective eletagy are also effective for mever high occurs obtained at a constant of the base leafs of the banishoot at the banish of the base leafs of the banish of the Thereford, when it is necessary to obtain these effects of the elements is preferably added. The affects these elements become significant at a content of $V_{\rm c} = 0.000$ for $V_{\rm c} = 0.000$ for the content of each section of the content of $V_{\rm c} = 0.000$ for $V_{\rm c} = 0.000$ for the content of the content of $V_{\rm c} = 0.000$ for the content of the content of $V_{\rm c} = 0.000$ for the content of th tends to deprease and this puriales may serve as introder that in intangito reduce the domeston resistance (2005) Accordingly when these elements are to be controlled the passimental their content should be controlled (4) Cr ± 1.58 · 0.08.0 · 10.0 · 0.00 10076). Calanc Molean for Simithe weld metal and improve the weld hot cracking resistance. For obtaining the effect [0088]: Referring to the weld metal; it is desirable that it is constituted of martensitic microstructures containing 5-30% austenite, phase, as already mentioned hereinabove. The reason why such metallurgical microstructures are desired is that the cracking (called weld not cracking) is to be prevented from occurring in the process of solidification from the molten state in the step of welding and the strength and toughness of the weld metal is to be improved. For preventing this cracking, a chemical composition should be selected such that ferrite phase occurs in appropriate amounts in the solidification process and in the cooling process after solidification and the ferrite phase disappears while the tempera ferfite phase, the presence of Ti reduces the region of the region metal in particular wb0.005 thodayor allabaruta [0089] By Those conditions under which ferrite phases can occur in solidification process should be taken into consideration and further, the weld metal should be constituted of martensite microstructure containing 5,30% by volume of austenite phases at ordinary temperature. For that purpose, it is desirable to properly select the contents of the ferriteforming elements Cr. and Mo, and austenite-forming element. Ni. while taking the contents thereof into consideration simultaneously. For the weled pipe of the present invention, the contents of CraNix Mo; and Trin the base metal should be within the following respective ranges: Cr: 15-20%, Ni: 4-7%, Mo::1-5-4% and Ti: not more than 0.015%; the contents of Cr. NicMocWand Ti in the weld metal should be within the following respective ranges: Cr. 11-18%; Nic 5-10%; Mo: 1.5-4%, W: 0-4% and Ti: not more than 0.03%; and the following relations (5) and (6) should be satisfied: 384 84 61 [0080] When the Piconlent exceeds 0.025%, the corrector is the land toughness of the base metal and well-

A semipandiard foliase migroit bina echasiase indice for $x \in \mathbb{N}$ fow to died. At 0.00 a name of direct particles of the 0.01 and the control of the 0.01 and the control of the 0.01 and 0.02 and 0.03 and 0.0

[0090] The relation (5) is directed to the ferrite phase formation in the process of solidification and the term "Cr + Mo - 1.7 x Ni" is an empirical formula indicating the tendency toward ferrite phase formation. As the value of this formula decreases; the ferrite phase yield decreases. However, when the value of this formula is less than 1, no ferrite phase exists:at high temperatures immediately after solidification, hence weld hot cracking tends to occur. On the other hand, when the value of this formula is excessively high, the ferrite phase yield becomes excessive; hence the toughness SCC cristanonites. The virtue lest specific movement of the control 25 4 times tungible 65 min. Freezeshood [0091]sic The Toughness of this weld metal is strongly influenced by the content of O (oxygen). When the relation of Cr + Moc-1.7.x Nii≦:13 g/220-x-0% in: which the O content is: involved, is satisfied the weld metal obtained can have Fig. 27 and Fig. 2B so that the bending emotins might action of the bonding amouseandpublished file. [0092] to Referring to the relation (6); the term "Cr + Mo + 1.8 x Ni" is an empirical formula indicating the tendency toward austenite phase formation. When the value of this formula is less than 25, the austenite phase yield is slight and no sufficient toughness;can be obtained. Conversely, when the value of this formula exceeds 301 the austenite phase yield becomes excessive, hence sufficient tensile strength and yield strength cannot be secured on the notificient tensile strength and yield strength cannot be secured on the notificient tensile. [0093] to The term "sufficient tensile strength" as used referring to the weld metal means that in a welded joint tensile test; failure occurs in the base metal portion but not in the weld metal portion. For the welded pipe of the invention, the weld metal should have a tensile strength of not less than 650 MPa so that the strength can be not below the X-80 grade (not less than 551 MPatintyleld strength), et a common and instructions as observation was made as observationally and the grade (not less than 551 MPatintyleld strength), et a common and instruction [0094] When the base metal satisfies the above relations (3) and (4) and the weld metal satisfies the relations (5) and/(6)) the welded piperof the invention can become one further improved in characteristics. See anomics a test to [0095]et in addition to the above features of the welded pipe, when the chemical composition of the base metal comprises! C: not more than 0:05%; Si: not more than 0.5%; Mn: not more than 21%; Cr. 9-17%; Ni: 0-9%; Wi: 0-1%, Cui 0-3%; V: 0-0.3%, Ca::0-0.01%; Ti: not more than 0.1% and the balance: Fe and impurities, and the chemical composition of the weld metal comprises: C: not more than 0.05%, Si: not more than 0.5%, Mn: not more than 0.5%, Or. 9-20%; Ni: 0-9%,†W: 0:3%@Cu::0-3%@V::0-0:2%@Ca::0-0.01%, B::0-0.01%, Ti:"not-more!than:0.1%"and:the_balance: Fel'and impurities, the welded pipe shows the highest level of SCC resistance, andre bear 11 bodg beit clave asw more trans-Sour gas resistance test The eare and number of cust spect entre which same an in the SCC resistance test. The conditions of bending stress application were the same as a conditions of bending stress application were the same as a conditions. bending amount Y (mm) were subjected to autorial a received. The attoriate examen, conditions were as follows: [0096] to The welded piperof the invention is most effectively used as a pipe for a pipeline for conveying a crude oil or natural gas while omitting the treatment for dehydration. In particular, when the side edge of one pipe is joined to the side edge of another by welding during a construction of a pipeline, the weld metal portion and the heat affected zone of the base metal need not be subjected to postweld heat treatment. Therefore, the pipeline can be used as welded condition. The side edge-to-side edge welding of pipes can be realized by applying such a welding method as the SAW [0106] The evaluation criteria were the same as the following bottom DAM to bottom DIM, bottom DIT, bottom

Method of producing the welded pipe:

Example

[0097]**The welded pipe of the present invention can be produced by a conventional method of producing ordinary. welded pipes. A general method of production is as follows: a strength method and two welder pipes. A general method of production is as follows: [0098] First, a hot strip or thick plate is cut to a width substantially equal to the outer circumference of the product pipe'. Then'tit is formed into a cylindrical form by the UOE method comprising forming by means of a Cipress; a Upress; a and an O press. The joining portions are then welded together by the SAW method to produce a welded pipe: In the forming stage; the UO method; spiral method; roll bending method or like method may also be employed as imade [0099]eaThe welding conditions as well as the flux and welding wire can be selected taking into consideration the chemical composition of the weld metal and other factors. In cases where a fine adjustment in hardness becomes defined in the API standard. The size of each think plater tutuo beirrab ed yem:thentheir balling grineqmetry season [0100] The chemical composition of the base metal to be used can adequately be selected considering the above [0109] For the thick plates given the symbols B. O. or feqiq-bellew entitoreauthébneani entrot gnibrocoa anoitibhéo [0101] siAs for the method of producing the hot strip or thick plate namely, the base metal, cany of the methods in conventional use may be employed. The hot strip or thick plate may be produced by the method comprising hot rolling accontinuously cast slab or the method comprising blooming a steel ingot; followed by hotrollingwent is noticed mos [0102] In producing the base metal with a ferrite phase proportion of 10-45% by volume (martensite phase proportion) of 55:90% by volume), the heating temperature for the material prior to hot rolling is desirably 1100°C-1250°C9At a heating temperature exceeding 1250°C; ferrite phases may precipitate abundantly in some instances; with the result that the metallurgical microstructures of the product cannot be constituted mainly of a martensite phase. At below 1100°C; the material steel shows high deformation resistance, hence is difficult to hot roll than send gold out with after the Remission Disension the world metal. Two lest suicing with the court 26 disension with and 185 tem long, for non ा 🕟 ार्ज के क्षेत्र प्रस्ति काला वर जन्महास्याम भित्र 🗸 स्माट and the more than the district of the property of the control of t

EXAMPLES of an increase solitations in exercing with the process of an increase of a material or the material of the process o

[0103] The test methods used in Examples 1 to 3 in common are as follows: Fig. 3 is a schematic drawing showing the sectional structure of the weld portion formed by the single pass weld material. 7 used in Examples 1 and 2 to be mentioned later herein awaren bis seemos is there was the more of the contract of government of a started that to bulk your results SCC resistance test: The size of test specimens was: thickness 5 mm x width 25.4 mm x length 165 mm. For each set of test conditions; one test specimen was prepared in Example 1 and two specimens were prepared in Example 2 and Example 3: A bending stress was applied by setting the test specimen 5 on a jig 6 for causing bending, as shown in Fig. 2A and Fig. 2B, so that the bending amount might arrive at Y (mm). "Y" is the bending amount arrived at when, a stress regual in value to the yield strength (YS) of the base metal is applied as o (bending stress) appearing in the equation; shown; in Fig.: 2B, at-room temperature. The test specimens, with this bending amount, given were subjected to autoclave treatment. The treatment conditions were as follows: atmosphere ≈ CO₂ gas at 30 atmospheres, test solution - 10% (by mass) aqueous NaCl solution at 100°C, immersion time in solution 5720 hours. The test specimens after treatment were observed by the eye for occurrence of cracking. In cases where the occurrence or nonoccurrence of cracking could not be confirmed definitely by visual observation alone, the section thereof was polished and then observed for occurrence or nonoccurence of cracking undersan optical microscope, especially sevent bloods them blood [0104] The evaluation was made as follows. When the number of test specimens was one, the case where no crack was found was judged good 🖫 and the case where cracking was found was judged defective "X". When the number of test specimens was 2, the case where either specimen showed no cracking was judged good "O"; the case where one, specimen, showed cracking was judged poor: "\D" and the case where both showed cracking was judged defective "X" CO2 resistance test: The size of test specimens was: thickness 2 mm x width 20 mm x length 50 mm. The test specimens, were subjected to autoclave treatment under the same conditions askin the SCC resistance test and exof the weld metal comprises: O not more than 0.05% S on the capabilities that, night and indicate and penime [0105] The CO2: resistance evaluation, was made as follows. The case where the dimensional loss was not more than 1 mm was evaluated good "O" and other cases were evaluated defective "X" awards edic peblew and seitinuami Sour gas resistance test: The size and number of test specimens were the same as in the SCC resistance test. The conditions of bending stress application were the same as in the SCC resistance test. The test specimens given the bending amount Y (mm) were subjected to autoclave treatment. The autoclave treatment conditions were as follows: atmosphere a CO2-gas, at 30 atmospheres with H2S gas at a partial pressure of 0.03 atmosphere, test/solution[3/10%] (by mass) aqueous NaCl solution with pH.4.5 at a temperature of 25°C; immersion time >720 hours. The test specimens after treatment were observed by the eye for occurrence of cracking. In cases where the occurrence or nonoccurrence of cracking could not be confirmed definitely by visual observation alone, the section thereof was polished and then observed for occurrence, or no noccurrence, of cracking under an optical microscope a abla-on-aging abit and nothing of [0106] The evaluation criteria were the same as in the SCC resistance test mentioned above, bodied: et al. performance test mentioned above, bodied: et al. performance test mentioned above, bodied: et al. performance test mentioned above.

Example 1

Method of moducing the welded plan

[0107]10 In Example 1, the relation between the weld bead shape and the SCC resistance was examined. Further the combinations of five base metals and two weld materials differing in chemical composition; metallurgical microstructures [0098] First a not strip or thick plate is out to a width substraction denimex, cala; energiate or thick plate is out to a width substraction denimex, cala; energy and the control of the [0108] Usina Table 15 there sare shown the chemical compositions and metallurgical microstructures of 5 thick plates (symbols A-E); namely base metals, the chemical compositions of the weld materials (symbols F and G) used and the chemical compositions; and metallurgical microstructures of the weld metals obtained from the combinations of these base metals and weld materials. All the base metals were martensitic stainless steels containing ferrite phase Each thick plate had been adjusted so that its strength was of the X-80 grade (not less than 80 ksi (55.1 MRa) in yield strength) defined in the API standard. The size of each thick plates for welding test was as follows: 12:7-25.4 mm thick: 300 mm [0100] The chemical composition of the base metal to an even can adequately be selected con.gnol-m. I.bna; biw [0109] For the thick plates given the symbols B, D or E, steel plate specimens (2) specimens for the one given the symbol B) for, actual pipe; making testing #1,920 mm wide and 6 m long; were prepared and four large-diameter; thick; wall welded pipes; 610;mm; in outside diameter and 6 m in length, were produced by the SAW method. The chemical composition of the weld material used in pipe making was that shown in Table 1 under the symbol G. The tests made for the welded pipes-correspond to the test numbers 33-36 in Table 4 arrel a 4th vision each and and prior to the test numbers 33-36 in Table 4 arrel a 4th vision each and and prior to the test numbers 33-36 in Table 4 arrel a 4th vision each and a 4th vision each [0110]) * (As) for the 300 mm. wide thick plates for welding testing; one edge, side, thereof in the width direction was subjected to bevel machining according to the plate thickness and the beveled portions were joined and welded together by the single-pass SAW method. Figs3 shows the sectional structure of the weld bead portion of the test specimen after this welding (hereinafter referred to also as "weld joint"). The symbol 7 denotes the thick plate (base metal) and the symbol 2 denotes the weld metal. Two test specimens 5, 5 mm thick, 25.4 mm wide and 165 mm long, for fourpoint bending testing, with a weld bead, were each taken from the site of that weld joint as indicated in Fig. 4 and

subjected to corrosion testing. As for the 6 m-long welded pipes, test specimens 5 for corrosion testing were each taken from the site shown in Fig. 5 judged to be the highest-in-the weld bead-portion h.

[0111] As for the weld metal, two chemical compositions were employed and the chemical compositions of the weld materials of the weld joint portions mentioned above are also shown in Table 1. For 32 single pass-welded materials and 4 welded pipe test specimens, the test specimen sizes and test specimen weld bead shapes as formed are shown in Tables 2 to 4 for the respective test numbers.

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	[0112] Antony the single pass where the transfer and the control of the control o	
	were the same as those of the single pass welded material of specimen number 2 and the materials of specimen	
	numbers 18-21 were the same as the single pass welded material of specimen number 17. However, the both sides	
	other than the length L had been cut off by cutting treatment to the same height as the base metal surface.	
5	[0113] And, each of the thus-obtained single pass weld materials and welded pipes was subjected to the following	
	tests as welded, namely-without any heat treatment after welding.	
	[0114] Each test specimen was subjected to tensile test, weld bead shape measurement, SCC resistance test, CO ₂	
	resistance test and sour gas resistance tests	
	[0115] The tensile test conditions in Example 1 were as follows:	
10	[0116] For both the single pass weld materials and welded pipes, the test specimen sampling site was in the direction	
	perpendicular to the steel plate rolling direction for the base metal portions and in the direction tangential to the direction	
	of seam welding, for the base metal portions and the size of each test specimen was as follows: 8 mm in outside	
	diameter and 60 mm in parallel portion length. The test temperature was 100°C or room temperature and, at the	
	temperature 100°C, the yield strength (YS) of the base metal and of the weld metal was measured and, at room	
15	temperature, the tensile strength (TS) and yield strength (YS) of each of the base and weld metals were examined.	
	[0117] The results of the above tests are also shown in Tables 2 to 4.2	
	[0110] The results shown in labes 2-to 4 indicate the following	
•	[0119] The single pass welded portions (specimen numbers 6-8, 10, 11, 13, 15, 16, 20-23, 25, 26, 28, 29, 31 and	
	32) and welded pipes (specimen numbers 33-36) satisfying the conditions defined by the present invention with respect	•
20	to the weld bead shape all showed good SCC resistance and were excellent in CO2 resistance as well.	
	[0120] As regards the sour gas resistance, the single pass welded portions and welded pipes other than those of	
	specimen n <u>umbers 20-23, 28, 29-31 and 32 where the Mo</u> content in the base metal was low showed good results .	
	From these results, it was confirmed that when sour gas resistance is required, it is desirable to employ another	
	measure for improving the sour gas resistance in combination with measures for satisfying the conditions defined by	
25	the present invention with respect to the weld bead shape.	
	[0121] On the other hand, those single pass welded portions which failed to satisfy the conditions defined by the	
	present invention concerning the weld-bead shape (specimen numbers-1-5, 9-12, 14, 17-19, 24, 27, 30) were all poor	
	in SCC resistance giral policy giral solutions and giral solutions	
	[0122] The specimens numbered 20-23, 28, 29, 31, 32 and 36 whose weld bead shape satisfied the weld bead shape	
30	conditions defined by the present invention were excellent in SCC resistance and further in CO ₂ resistance. Their sour	
	gas resistance was poof, however:	
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	Example 2	
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35	[0122] In Example 2, the wolded pines satisfying the wold beed shope conditions defined by the invention namely	
35	[0123] in Example 2, the welded pipes satisfying the weld bead shape conditions defined by the invention, namely	
	welded pipes showing good SCC resistance, were examined to find out the desirable conditions concerning the chem-	
	ical composition and metallurgical microstructure of the base metal. In particular, the conditions to be satisfied by the	
	base metal, even as welded to have good sour gas resistance and toughness were researched.	
	[0124] The chemical compositions of 26 kinds of steel (base metals) tested are shown in Table 5. The 24 steels	
40	designated Nos.a-uzandx-z were each worked up into a plate, 25 mm thick, 120 mm wide and 400 mm long, by the	
	process of melting each steel in a small melting furnace, casting it into an ingot, heating the resulting casting at 1200°C,	
	hot forging the same into a slub and, further, hot rolling the resulting slab under the following conditions: number of	
	passes = 5, finishing temperature = 980°C. The steel designated Nos.s-u were those in prior art. The steels designated	
	No.v and w were thick plates, 19 mm in thickness, for pipe production as produced in an actual plant.	
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EP 1 179 380 A1 [0125] A welding wire, 4 mm in diameter, containing C: 0.01%, Cr. 12%, Ni: 9% and Mo: 3% by mass and a high basicity bond flux were prepared as the weld materials. [0126] And, mimicking the actual welded pipe production process, the side edges, parallel to the direction of rolling, of each plate prepared were worked to give Y shape bevels with an angle of 60 degrees and a root face height of 13 mm and the worked portions were butt welded. Single pass welding was performed by the SAW method and the weld heat input was 7.5 kJ/mm. [0127] Then, the test specimens medicined below were taken from the base metal portion and butt welded portion after welding and examined for mechanical properties (yield strength and toughness) and sour gas resistance. [0128] The tensile test specimens for yield strength measurement were taken from a site in the direction perpendicular to the direction of rolling of the base metal and had the shape of a round bar with a diameter of 4 mm and a gauge length of 20 mm | 10 mm and a gauge length of 20 mm | 10 mm and a gauge length of 20 mm | 10 mm and a gauge length of 20 mm and a gauge len pendicular to the direction of rolling and had the shape of No. 4 specimen standardized in Jis Z 2202 (1980) (length: 75 mm, width: 10 mm, notch: 2 mm V). The Charpy impact test specimens were cut out from both the base metal and butt welded portion. The No., 4 specimens cut out from the butt welded portion were notched in the weld bond portion (boundary between the fusion zone and unfused zone). The toughness was evaluated in terms of vTrs. [0130] The test specimens for sour gas resistance test were taken from a site in the direction perpendicular to the direction of rolling and we're V-notched 4-point bent beam test specimens 2 min in thickness, 10 mm in width and 75 mm in length. As for the number of specimens, two were taken from the middle in the direction of thickness for the base metal and for the butt welded portion. The 4-point bent beam test specimens cut out from the butt welded portion were notched in the weld bond portion in the same manner as the above-mentioned Charpy impact test specimens. [0131] The bending stress applied in sour gas resistance test was as mentioned above. The specimen treatment conditions were as follows atmosphere carbon dioxide gas at a partial pressure of 30 atmospheres and H₂S gas at a partial pressure of 0.01 atmosphere, solution - an aqueous solution containing 5% by mass of NaCl at a temperature of 25°C, immersion time. 200 hours The sour gas resistance was evaluated by the method mentioned above. [0132] The results of material characteristics evaluation are shown in Table 6, together with the calculated values for confirming the relations (3) and (4) defined by the present invention concerning the desirable chemical composition of the base metal. 30

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5	of cracking in the resistance was [0141] The telength of 110 mr line so that the perature was remetal portion ar [0142] The Cition perpendicu	e weld mei indicated to st specime mand a gal parallel po som tempe and by "X" (I harpy impa lar to the w	tal portion by "O" (gens for te uge lengorition co rature. I poor) which test seed bear to be a seed to be a seed bear t	ons of the pood), and ensile tes other the test represented the factoring of the state of the st	above welde when crack! t were No. 5 mm. The spe ne weld meta esults were in illure occurre s for toughness becimens had	ed pipes. When was obseed the second of the	en no crack with the distribution of the distr	the occurrence or as observed, the we coor). JIS Z 2201 with a irection perpendiculate and base metal and the failure occurrence occurrence and base metal and the failure occurrence and base metal and base metal and base metal and base metal bases in Example 2 a	parallel portion parallel portion lar to the fusion .—The test tem- red in the base pint in the direc- nd the notch o
15	toughness was absorbed energ [0143] The te and 165 mm in	evaluated by was not st specime parallel po	in terms less tha ens for so ortion ler	of absor n 50 J âr our gas re ngth. The	bed energy v d_as_poor "X" esistance test specimens v	E _{-30°C} . The when it was thad the sha were taken in	toughness wa Jess than 50 pe of a plate, the direction	5 mm in thickness, perpendicular to th	d "O" when the 20 mm in width e fusion line so
20	reinforcement of application and [0144] The w which was twice	of weld, one the autocli orkability we the plate	e side re ave trea vas eval thicknes	tained it tment co uated by s. The te	and the rever nditions were a test comp st results wer	se side was as mentione rising bendin e indicated b	ground smoot d above \ g the butt we y_"O" (good w	of the specifing lenthly. The method of lenthly lenthl	bending stress
25	or like trouble o		are sumi		n Table 9.		×lololo	effenet 305 effenet	
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[0146] The specimens numbered 4, 6-8, 14 and 16-18; all satisfying the relations (5) and (6) defined by the present invention, gave good results in all characteristics, namely sour gas resistance; toughness, weld not cracking resistance, workability and tensile properties. The specimen numbered 13, however, which satisfied the relations (5) and (6), was inferior in sour gas resistance since the Cr content was 10.4%, thus rather low. From this result, it was confirmed that for providing the weld metal with sour gas resistance, it is recommendable to increase the Cr content to 11% or above while satisfying the relations (5) and (6) simultaneously.

[0147] The specimens given other numbers than those mentioned above failed to satisfy at least one of the relations (5) and (6) and, except for specimen No. 5; they were poor in at least one of sour gas resistance and toughness. The specimen numbered 5, which was an example in which the austenite phase proportion in the weld metal portion was as high as 40% by volume, was good in sour gas resistance and toughness but too low in tensile strength.

YTIJIBADIJPAA JAINTRUDINI the contents of R. S. and O. (oxygon) which the includies of the both the bare meter and weld meter. He had

[0148] The martensitic stainless steel welded pipe of the inventions is excellent in corrosion resistance of pipe inside surface weld portion, in particular in SCC resistance, in spite of its being a large-diameter, thick-wall welded pipe. Further, the sour gas resistance, toughness and weld not cracking resistance can be improved by selecting the chemical composition. Therefore, it is very suited for use as a pipe for a pipeline for conveying a crude oil or natural gas highly corrosive to metals while omitting dehydration treatment.

DOMESTIC A CALL

Claims

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1. A martensitic stainless steel welded pipe which comprises a base metal which is a stainless steel containing, on the mass % basis, not more than 0.05% of C and 9-20% of Cr and having a metallurgical microstructure comprising a full martensite phase or a martensite phase as the main constituent with a ferrite phase contained therein, and a seam weld metal which is a stainless steel containing, on the mass % basis, not more than 0.1% of C and 7-20% of Cr and having a metallurgical microstructure comprising a martensite phase as the main constituent with an austenite phase contained therein, a seam weld bead on the inside surface satisfying the following relation(1):

> L ≦ 0.2 x W (1)

where L: the length of the portions of the seam weld bead showing a value of h which exceeds 1.25 as calculated by the expression (2) shown below:

 $h = \{1 + (2 \times H/W)\} \times (YS_{B100}/YS_{w100})$ A welded pipe as claimed in Claim 1 or 2 wheren the Later the weld metal in the spam portion respectively

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have the following chemical compositions on the med. "With

28 5 Cramb 4 1 3 11 30

H: the height of the bead from the pipe inside surface (mm),

W: the width of the bead (mm) Base moult. W: the width of the bead (mm), YS_{B100}: the yield strength of the base metal at 100°C (MPa); con ton YS_{w100}: the yield strength of the weld metal at 100°C (MPa). fisherice in Ferimpurities

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A welded pipe as claimed in Claim 1, wherein the metallurgical microstructure of the base metal is constituted of, on the volume % basis, 55-90% martensite phase and 10-45% ferrite phase and that of the weld metal is constituted of, on the volume % basis, 70-95% martensite phase and 5-30% austenite phase, and wherein the chemical compositions of the base metal and weld metal are, on the mass % basis, as follows:

Base metal: 0.001-0.1%, Si 0.01-1%, sol. Alaoithugar sa Mn 0-0.5%, 🕠 0.05-2%, ٧ -Ni 0-9% .7r. 0-0.5% 0-0.05% was no sathbook to a still disection of 0-5%, ,Ca ska ferri ni na La adum 0-0.05%, margarage 0-6%, Mg of safar the endi-0-5%. Ti not more than 0.1%.

กรรม เหมืองได้ ข้อ ข้อเหมือง เชื่อ	មិនដូច១ មិន១ ប៉ុន្តែទេ។ ប	(co	intinued) 🦈				
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प्रतास के दूर है के उसके कर अंग एक कहा विवर्धन करा है।	Weld metal: Si	0.01-1%,	sol. Al	0.001-0	0 - aáine tr 1%, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	State of the state	מוקריים ביל הולמו מינות ה
ok eyen i jên în ta shab	Contagnon Mn	0.05-2%,	V	0-0.3%,	osa a seria. Beledining	COW TOTAL	n in la line. Millen e en
	Ni	0-10%,	Zr. ann≎ce	0-0.3%,	tonia Magnetic	। स्वतन्त्रसम्बद्धाः	शामक राज्य
राज्यातीना वृत्ती कि भारत स्क्रानी	ાદ પોસાક્ષક ગામ સાફિપ્ય	. 0-5%,:					
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क्षुत्रच स्व कर्न व	ness but the low that	9 1 37 1 V	- Balance s	Fe?'impû	ritiês:sw em	40% Dr. AOL	as high as

the contents of P, S and O (oxygen) among the impurities being, for both the base metal and weld metal, P: not more than 0.025%, S: not more than 0.01% and O: not more than 0.01%, and the content of N being not more than 0.02% for the base metal and not more than 0.05% for the weld metal.

Than 0.02% for the base metal and not more than 0.05% for the weld metal.

The standard metal metal and not more than 0.05% for the weld metal.

A welded pipe as claimed in Claim 1 or 2, wherein the contents of Cr. Ni and Ti in the base metal are, on the mass % basis, Cr. 11-20%, Ni: 3-7% and Ti: not more than 0.05%, with the following relations (3) and (4) being satisfied:

Cr + 1.5Mo - Ni - 0.4Cu - 14 ≥ 0

(3) Clain:s

ാം gnimamon രണ്ടെ അമിനിലും ഒരു ദിവിത്തിലൂന്നു 1.5Mo -⁄2Ni.- 0.8Cülirl 2:55≦0olow leets വാത്രങ്ങനില്ലെക്ക് A (4) the mass 8, bears not nece than 0.05% of Cland 34,0% of the having a metallurgical interconnection normalisms

4. A welded pipe as claimed in any of Claims 1 to 3, wherein the contents of Cr. Ni, Mo and Ti in the base metal are, on the mass % basis, Cr. 15-20%. Ni: 4-7%, Mo: 1.5-4% and Ti: not more than 0.015%, and the contents of Cr, where it is a content of the conten Ni, Mo, W and Ti in the weld metal are, on the mass % basis, Cr: 11-18%, Ni: 5-10%, Mo: 1.5-4%, W: 0-4% and Ti: not more than 0.03%, with the chemical composition of the weld metal satisfying the following relations (5) and (6):

- 1 ≤ Cr + Mo - 1.7Ni ≤ 13 - 220 x O (oxygen)

(5)

where Li the length of the portions of the seam welch consistence is white of a which exceeds 1.25 as parchiago by the expression 12 interval pages

 $25 \le Cr + Mo + 1.8Ni \le 30$.

MARKET OF THE A 5. A welded pipe as claimed in Claim 1 or 2, wherein the base metal and the weld metal in the seam portion respectively have the following chemical compositions on the mass % basis:

	Base metal:	С	not more	than 0.05%	, Cu	eight of the boad from t	and a
		Si	not more	than 0.5%,	V	eath of the beet (11.0)	eadi :W
		Mn	not more	than 1%, -		0-0.01% erts blev ed-	
		Cr				not more than 0,1%,~	
	_	Ni	0-9%,			Fe, impurities,	
់។ ២៧ម៉ូម៉ែកកា។ ស	siem easd anti-	cW: ^{cd}	۰0-1%;∵۳	· · · · · · · · · · · · · · · · · · ·	r odFrajarenw	ре на обствот г. Овјит 1	iq heldow a
						`Cú: 0-3%;३३ अक्टबं ∾° ६	
าย ด้ายกรัสสุด 20ท						70-0:2%, 3250 % cmu	
		"Mh ^o "	not more	than 1%,	Čā laiem	the base meta %f6.0 20	to annual to
		-Cr	9-20%,~		В	-0-0:01%;	
		Ni .0	0-9%,	7	$\hat{\Pi}^{0}$	-0-0:01%; not more than 0.1%,	
		W 1	૽ ૢૺૼઌૺ-ૢ૽ૼૺૹૢૺૺૺૢ	Č	Balance	Fe, impurities.	,

6. Use of a welded pipe as described in any of Claims 1 to 5, in a line pipe for conveying a crude oil or natural gas with no dehydration treatment. au, maré than 0 1%

10

15

20

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45

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Fig. 17

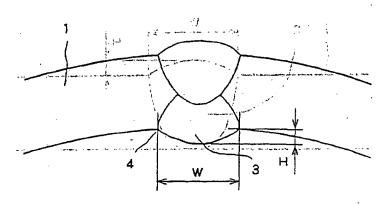


Fig. 2A

s 4

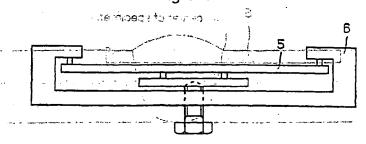


Fig. 2B

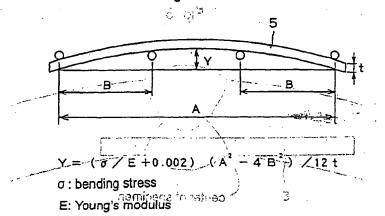


Fig. 3

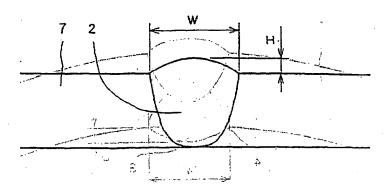


Fig. 4

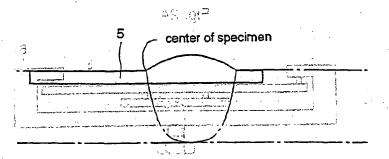


Fig. 5

Fig. 5

Scenter of specimen

Center of specimen

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/05296

A. CLASSIFICATION OF Int.Cl 7 B23K	SUBJECT MATTER 19/02, 9/23		
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	atent Classification (IPC) or to both no	GIORE CLESSIFICATION and IFC	
B. FIELDS SEARCHED	urched (classification system followed	by classification symbols)	
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Jitsuyo Shinan Kokai Jitsuyo	Koho 1926-1996 Shinan Koho 1971-2000	extent that such documents are included Jitsuyo Shinan Toroku F Toroku Jitsuyo Shinan k	Coho 1996-2000 Coho 1994-2000
		ne of data base and, where practicable, sea	rch terms used)
C. DOCUMENTS CONSI	DERED TO BE RELEVANT	 	
	of document, with indication, where ap	<u> </u>	Relevant to claim No.
	2233, A (Hitachi Ltd.) er. 1994 (25.10.94) (Fe		1-6
	129, A (Toshiba Corpora 129, 1997 (04.02.97) (1		1-6
	·		
Further documents are	listed in the continuation of Box C.	See patent family annex.	
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Date of the actual completion 31 October, 2	n of the international search DOD (31.10.00)	Date of mailing of the international sear 07 November, 2000 (
Name and mailing address of Japanese Pate		Authorized officer	
Facsimile No.		Telephone No.	

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